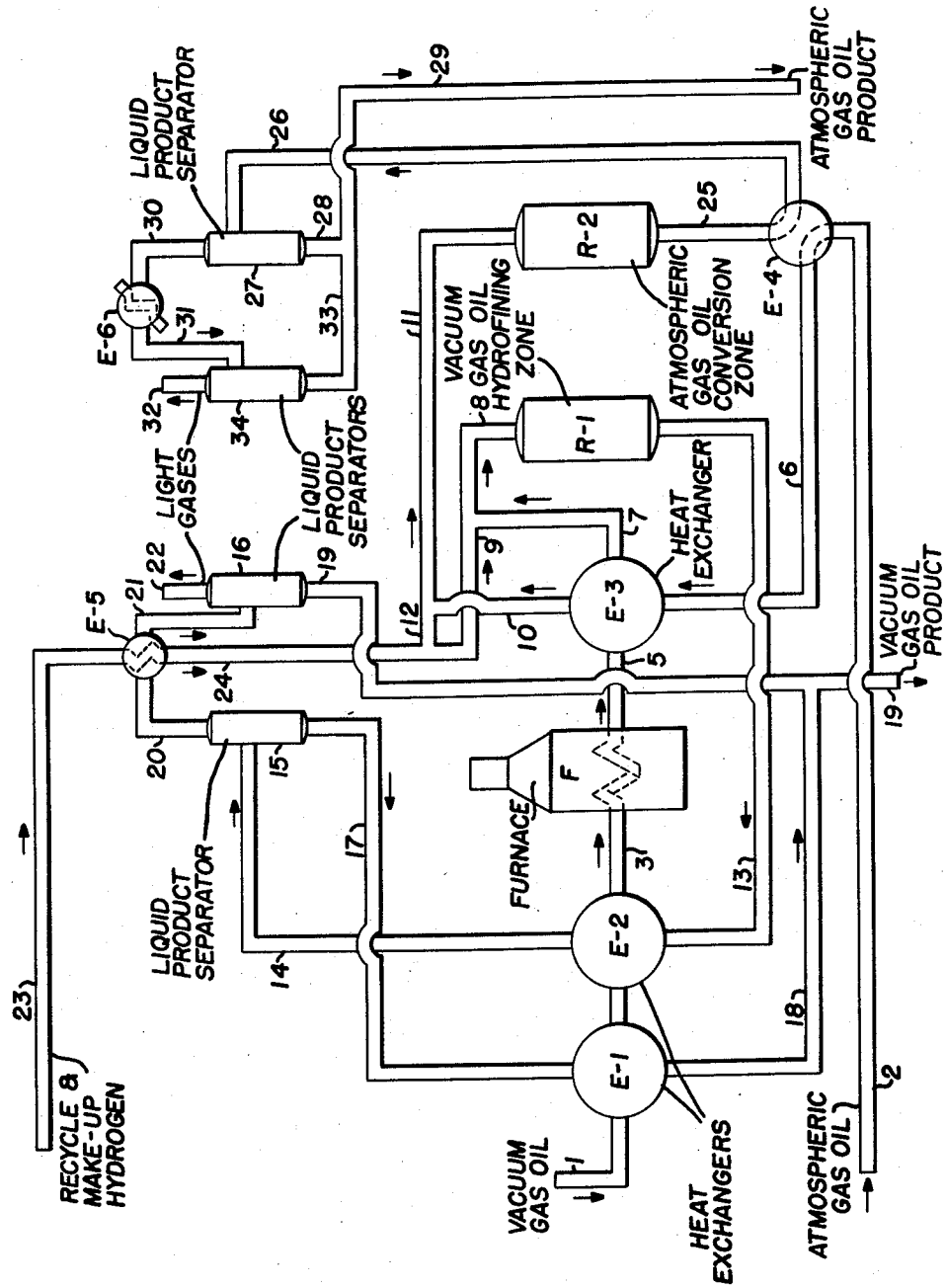
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COMBINATION HEAT EXCHANGE AND HYDROFINING PROCESS

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COMBINATION HEAT EXCHANGE AND HYDROFINING PROCESS

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This invention relates to an improved combination hydrofining process. It is more particularly concerned with an improved method of heating the charging stocks to reaction temperatures in a hydrofining process simultaneously treating two different charging stocks in separate reaction zones, whereby the flexibility, efficiency, and operability of the process is greatly improved.

In brief compass, this invention proposes an improved combination hydrofining process wherein a first petroleum oil and a second petroleum oil are hydrofined in separate hydrofining zones, at a first and second hydrofining temperature respectively, each in the presence of a hydrofining catalyst and free hydrogen. The improvement of this invention relates to a method of heating the oils to hydrofining temperatures. This method comprises heating the first oil in a furnace to a high temperature substantially above the first hydrofining temperature, and then heating the second oil to the second hydrofining temperature by indirect heat exchange with the first oil. This indirect heat exchange lowers the temperature of the first oil to the first hydrofining temperature.

The prior art is familiar with hydrofining processes used to improve the quality of petroleum products, particularly petroleum distillates. The hydrofining process is used to reduce the sulfur content and to improve other qualities of the oil. The oil is hydrofined by mildly hydrogenating it in the presence of a hydrofining or hydrogenation catalyst and free hydrogen. It is conventional to recover and recycle hydrogen-containing gas from the reaction zone effluent, and to add make-up hydrogen as is necessary. The catalyst can exist as a fixed, gravitating, or fluid bed, and can be periodically oxidatively regenerated as required. Conventional hydrofining catalysts include catalysts such as cobalt molybdate, and/or molybdena on alumina, and/or mixed oxides of cobalt and molybdenum on alumina. Alumina, containing 2 to 5 wt. percent cobalt oxide and 10 to 15 wt. percent molybdenum oxide is a preferred catalyst.

Any hydrocarbon oil can be treated by this process, including shale oils, synthetic oils, whole petroleum crudes and fractions therefrom including light naphthas through heavy residua. It is preferred that the feed stocks be contiguous cuts from an oil, but this is not essential.

There are frequent instances where it is desirable to hydrofine more than one product. It is, however, often inconvenient to run a "blocked" operation in a single unit, i.e., alternately treat different feed stocks. For this reason, it has been the practice in the past to use two essentially separate circuits or passes to handle two different feed stocks, each circuit consisting of a furnace, a reactor, a separator, and associated equipment. Some economies have been realized in this design by using a common hydrogen gas recycle system for the two circuits.

This invention proposes an improved parallel pass or combination hydrofining process wherein only one furnace is used to heat the charging stocks to reaction temperatures.

It has also been proposed to eliminate one furnace in a parallel pass hydrofining system by using one furnace with two essentially separate oil heating circuits or passes of different lengths and outlet temperatures. This type of furnace is, however, extremely inflexible and difficult to operate. The difficulties do not justify the economies realized by using a single furnace in this manner.

This invention also proposes a process whereby the economies of using one furnace are realized without encountering the inflexibility and operating difficulties of previously proposed parallel pass furnaces used in combination hydrofining units.

In essence, this invention involves heating the lighter oil feed to a combination hydrofining process to reaction temperature by indirect heat exchange with the heavier oil feed, which has been initially heated to a temperature substantially higher than that at which the heavier oil is to be converted.

The following description of the drawing attached to and forming a part of this specification will serve to make this invention clear. For convenience, the operating conditions applicable to this drawing are summarized in Table I, presented hereinafter.

Referring to the drawing, a vacuum gas oil which is to be treated for sulfur reduction and to improve catalytic cracking characteristics, is introduced into the process by line **1**. A second feed, atmospheric gas oil, which is to be desulfurized for quality improvement, is introduced by line **2**. Normally a hydrofining unit to handle these two feed stocks would be designed with two furnaces—one for each stream. The vacuum gas oil in line **1** is intially preheated in feed and product heat exchanger E–**1**, and feed and reactor effluent heat exchanger E–**2**, and is then passed to a radiantly heated tube furnace F by line **3**. In the furnace it is heated to a temperature substantially higher than that at which it is to be converted. After this, it is passed to heat exchanger E–**3** by line **5**.

The atmospheric gas oil in line **2** is initially preheated in heat exchanger E–**4** by heat exchange with the effluent from one of the reactors, and then is passed to heat exchanger E–**3** by line **6** and heated to its hydrofining temperature by heat exchange with the high temperature vacuum gas oil. This heat exchange in heat exchanger E–**3** brings down the temperature of the vacuum gas oil to its reaction temperature.

The vacuum gas oil at the desired reaction temperature is passed from heat exchanger E–**3** by lines **7** and **8** to reactor R–**1**. Necessary hydrogen is added to the vacuum gas oil by line **9**. The atmospheric gas oil is passed from the heat exchanger E–**3** by lines **10** and **11** to reactor R–**2**. Hydrogen is added to the atmospheric gas oil by line **12**.

Reactors R–**1** and R–**2** contain fixed beds of a hydrofining catalyst and the oils are treated therein under conventional hydrofining conditions to an extent sufficient to obtain the improvement desired.

The effluent from reactor R–**1** is transferred by line **13** through heat exchanger E–**2** and then by line **14** to a separation system comprising, in this example, knockout drums **15** and **16**. A heavy fraction of the vacuum gas oil is separated in drum **15** and transferred by line **17** through heat exchanger E–**1** and then is removed as product by lines **18** and **19**. The lighter constituents are removed overhead by line **20**, cooled in heat exchanger E–**5**, and passed to drum **16** by line **21**. The material condensed in drum **16** is removed by line **19** and mixed with the product in line **18**. The light gases are removed overhead from drum **16** by line **22** and sent to purification system to recover hydrogen for recycle.

The necessary hydrogen, for example, from the purification system, is supplied to the process by line **23**, pre-

heated in heat exchanger E–5, and transferred by line 24 to lines 12 and 9, previously discussed.

The effluent from reactor R–2 is passed by line 25 through heat exchanger E–4 and then to a separation system by line 26. The separation system in this example comprises two knock-out drums similar to the ones previously described. The treated atmospheric gas oil from line 26 is initially separated in drum 27. The condensed material is removed from the drum by lines 28 and 29 as product. The lighter material is withdrawn overhead from drum 27 by line 30, cooled in heat exchanger E–6, and passed by line 31 to the second drum 34. Light gases are taken off overhead from drum 34 by line 32, sent to the purification system, and the condensed material is removed from the bottom of the drum by lines 33 and 29 as product.

It is preferred to use the heavier oil being hydrofined as the material to transfer heat to the other oil being treated because the heavier oil is usually treated at a higher temperature. In some cases, the proportion of lighter oil being treated, to the heavier, may require that it be used as the heat carrier. Also, there may not be, in some cases, any practical difference between the boiling points or gravities of the oils being treated.

The heavy gas oil unit R–1 is shut down periodically for regeneration. The regeneration gases, however, will be heated in the furnace and will provide heat for the light gas oil unit R–2 in heat exchanger E–3. The light gas oil unit R–2 can be run, therefore, while the heavier gas oil unit R–1 is on regeneration. If unit R–2 is shut down, then heat exchanger E–3 can be used for other purposes, for example, to manufacture steam, or the furnace outlet temperature can be reduced to the appropriate temperature level. If a parallel pass furnace had been used in either of these cases, it would have been practically impossible to maintain the desired hydrofining temperatures while maintaining the proper skin temperatures on all of the tubes of the furnace.

Table I summarizes the operation conditions applicable to the above described drawing, and presents a specific example.

Table I

	Preferred Range	Example
Preheat Conditions:		
Proportion of heavier oil to lighter oil	100 to 1	2.7
Maximum temperature of heavier oil, ° F.	800	770
Temperature of heavier oil after heat exchange, ° F.	600 to 750	730
Temperature of lighter oil after heat exchange, ° F.	550 to 750	700
Hydrofining Conditions of Lighter Oil:		
Temperature, ° F.	550 to 700	675
Pressure, p.s.i.	200 to 800	350
Feed rate, vol./hr./vol. of catalyst (v./hr./v.)	0.5 to 8	2
Hydrogen partial pressure, p.s.i.	100 to 800	250
Hydrogen consumption, std. cu. ft./bbl.	25 to 150	50–100
Catalyst		(1)
Hydrofining Conditions of Heavier Oil:		
Temperature, ° F.	650 to 750	700
Pressure, p.s.i.	200 to 800	350
Feed Rate, v./hr./v.	0.5 to 4	2
Hydrogen partial pressure, p.s.i.	100 to 800	250
Hydrogen consumption, std. cu. ft./bbl.	25 to 300	150
Catalyst		(1)

[1] Mixed oxides of Co and Mo (fixed bed, ⅛–¼" pills).

Having described this invention, what is sought to be protected by Letters Patent is succinctly set forth in the following claims.

What is claimed is:

1. In a combination hydrofining process wherein a minor proportion of light petroleum oil feed is catalytically hydrofined in a first hydrofining zone at a temperature in the range of 550° F. to 700° F. and a major proportion of a heavier petroleum oil feed is catalytically hydrofined in a second hydrofining zone at a temperature in the range of 650° to 750° F. the improved method of heating said oils to said hydrofining temperatures which comprises heating the heavier petroleum oil feed to a temperature above the temperature range maintained in said second hydrofining zone, bringing the heated heavier petroleum oil feed into indirect heat exchange with said lighter petroleum oil feed thereby heating the lighter oil to a temperature of from 550° to 700° F. for charging to said first hydrofining zone and cooling the heavier oil to a temperature of from 650 to 750° F. for charging to said second hydrofining zone.

2. The method as defined in claim 1 in which the lighter petroleum oil feed is preheated by indirect heat exchange with the products from said first hydrofining zone and then heated to reaction temperature by indirect heat exchange with said heated heavier petroleum oil feed.

3. The method as defined in claim 2 in which the heavier petroleum oil feed is first preheated by indirect heat exchange with the reaction products from said second hydrofining zone and then further heated to a temperature above 650° to 750° F. for indirect heat exchange with the partially preheated light petroleum oil feed.

4. The method as defined in claim 1 wherein hydrogen-containing recycle gas is separated from the products from both hydrofining zones, purified in a common purification system and the recycle gas is then returned to said hydrofining zone.

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